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AN INVESTIGATION INTO UTILIZING WOOD WASTE IN THE LEWIS AND CLARK COUNTY AREA FOR SPACE HEAT IN MEDIUM-SIZED BUILDINGS

Prepared for

MONTANA DEPARTMENT of NATURAL RESOURCES and CONSERVATION

AN INVESTIGATION INTO UTILIZING WOOD WASTE IN THE LEWIS AND CLARK COUNTY AREA FOR SPACE HEAT IN MEDIUM-SIZED BUILDINGS

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November, 1980

Prepared for

Montana Department of Natural Resources and Conservation
32 South Ewing, Helena, Montana 59620
Renewable Energy and Conservation Program
Grant Agreement Number 301-801

Available from

Montana State Library, 1515 East Sixth Avenue
Justice and State Library Building, Helena, Montana 59620

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INTRODUCTION

The majority of this project consisted of primary research involving a great deal of discussion with a wide range of professionals in divergent fields. The project commenced with interdisciplinary discussions with professionals in alternative technology groups and project participants which led to more specific investigations. As Project Coordinator I traveled approximately 2,850 miles directly related to this project and talked with more than eighteen professionals as well as at least eight representatives of manufacturers of related equipment.

I worked in excess of 1200 hours conducting interviews and discusions, reading primary reports and compiling data. Albert Lunborg of Helena was patient and generous enough to provide me with his wealth of business and professional experience as well as donate a fully equiped office to the project for a period of six months.

One personal vacation of mine turned out to be both business and pleasure as I visited the Bio-Mass Center at the University of Arkansas where I observed and interviewed equipment operators. Finally, I have discussed the conclusions of this project in detail with at least ten people who understood the nature of this project and concur with the results.

Much of the original enthusiasm this writer had for this project came from the Oregon experience in utilizing wood wastes. Most significantly the University of Oregon's system of utilizing waste wood for steam and electrical

generation and the well known Eugene, Oregon based company, the Bio-Solar Research and Development Corporation, that is championing the cause of Densified Biomass Fuel.

The University of Oregon at Eugene has had an impressive system in place since 1949. They are able to totally heat 107 Buildings, a total of 3,280,000 square feet and generate enough electricity to service the entire campus. The adjacent Eugene Water and Electric Board (EWEB) also generates electricity with wood wastes and frequently through the years the University has sold excess electricity to EWEB.

The University claims it can now produce one million btu's for 35 cents, whereas using fuel oil would be a staggering six to seven dollars per million BTU's. This figure however does not take into account two very key costs: 1) the increase in personnel (21 full time employees) and 2) increased and ongoing maintenance cost. (No data available.)

In 1949 the University saw an opportunity which, from that time until present, has made good economic sense for at least two prime reasons: 1) a continuous abundant supply of high quality, low cost wood waste; and 2) the scale of operation. Oregon is blessed with a long growing season and consequently the timber industry is comparatively large. Numerous saw mills in close proximity to Eugene have provided large volumes of wood waste (hog fuel) at a low cost. The University is large and hence economies of scale become crucial. They currently have one massive 110,000 pound boiler and three 35,000 pound boilers.

However, two negative factors about wood waste utilization surfaced from the Eugene experience: 1) between the spring

of 1979 and the spring of 1980, the price of hog fuel went from $11 per ton to $22 in Eugene, Oregon; and 2) the plant supervisor was not in favor of wood waste systems because, a) continuous personnel problems (a hot, dirty and complex job), b) numerous and frequent equipment breakdowns in addition to continual maintenance.

Because of the downturn in the building industry essentially the price of wood fuel doubled in less than one year. Aonther resulting factor was that the quality of the fuel also diminished. Bill Norwood, the plant supervisor maintained that the problem of sand and grit in the low quality fuel had never been so severe. Ash removal consequently became an increasing burden exacerbating this already unpleasant task.

It is important to note that the Bio-Solar Corporation, the Eugene based company promoting Woodex^R Biomass densification manufacturing plants buys its raw material on the open market, the same material the University uses. Academic experts at the University were quick to alert me to this key discrepancy: Bio-Solar has a contract to provide Woodex^R pellets to the State Hosiptal in Salem at $28/ton. Please recall the price of raw fuel (hog fuel) of $22/ton. Since the Woodex^R patented process removes the moisture from the raw source and compresses or densifies it, clearly it requires considerable raw material compared to the end product, i.e., Woodex^R (one source suggests about a factor of three). If the above assumptions are correct, clearly Bio-Solar is not proving this method ecomonical. It should also be mentioned that Bio-Solar transports the fuel from Brownsville to Salem as part of the contractural agreement.

It is the strong opinion of this writer that the Woodex[R] process is neither practicable or economically feasible. My visit left me bewildered when a company official told me it would not be possible to visit the Brownsville plant anytime during the one week period of my visit "because some VIP's were going through it." The same company official (Paul Levine, Marketing) attempted to explain to me that Woodex[R] was not ordinary densified biomass fuel, but rather a special type of refined biomass fuel with a certain "molecular alignment" that would increase the BTU content. This writer found this claim totally without substance.

The following day this writer traveled to Corvalis, Oregon to meet with Ray Carrier of Oregon State University, Corvalis. Professor Currier was of the opinion that I was not allowed to visit the plant because of equipment break-downs, a frequent problem with the Woodex[R] plants. Bio-Solar is in the business of selling franchises on manufacturing plants that manufacture Woodex[R] pellets. Bio-Solar itself actually owns only two of six plants now in operation.

The Guarantee Performance Company maintains an Office in Tigard, Oregon where I pursued an interview with John Wesphal, Vice-President of Marketing. Mr. Westphal maintained that his company's entrance into the DBF field at this point was a losing proposition. The company has had one plant in Stillwater, Minnesota, which will soon be dis-assembled and moved. He pointed to two distinct problems in Minnesota: 1) an exhausted source of supply, and 2) frequent and costly breakdowns.

At this point with tax incentives and government loan guarantees, the company will soon try again, constructing a plant in the southern United States. Guarantee Performance Company does not sell franchises at this point but rather enters what is called joint agreements with parties constructing their plants. Guarantee provides the technical assistance, the other party provides the capital. At the time of this writing, it is the opinion of this writer that DBF plants are not economically practical. (See Densification Section)

WOOD AS A RENEWABLE ENERGY SOURCE

ENVIRONMENTAL AND ECOLOGICAL CONCERNS

Much of the interest in recent years in wood as a renewable energy source has, in the opinion of this writer, been shortsighted and in many ways an oversimplification.

It is well worth noting significant regional variables. Rainfall, sun, soil type, temperature, are key variables that even the best of silvicultural practices cannot alter.

For example, in parts the Pacific northwest and in portions of the south, with average prevailing geographic conditions, one Douglas Fir seed can be expected to grow to an average weight of 100 pound in 18-22 years. The same results in the Rocky Mountains can be expected to require 90-100 years. With this in mind, it will certainly behoove us to use this renewable source wisely, with sensible silvicultural practices. Notwithstanding, wood's somewhat limited renewability, overall ecological and environmental problems could result from intensive utilization of our timber for an energy source.

It can be argued, and convincingly, that leaving slash for a time provides a hamlet for small animals and birds. In addition, it is argued that leaving slash or burning it in place eventually provides necessary orgainc material for reforestation processes, as well as an aid in erosion control.

Wood burning results in greater amounts of particulates and hydrocarbons and can greatly contributes to haze in urban areas. On the positive side, wood buring results in lesser amounts of sulfer dioxide (SO_2) than either coal or heavy oils. It should be pointed out that health hazards for related substantive amounts of particulate emmissions are not known. However some researchers suggest particulates can be carcinogenic.

There is, however, pollution control equipment readily available for industrial size boilers.

SUPPLY

The first step and perhaps the most crucial in considering any wood waste utilization system is supply. Traditionally, the forest products industry is the prime user of wood wastes, or sawmill wastes, as a source of steam generation. However, a long history of waste wood for energy also exists in unrelated institutional settings in close proximity to areas where the forest products industry is strong. At any rate the prime advantages the saw mills have had are two fold: 1) limited transportation cost; and 2) continued guarantee of a ready supply. A host of variables can easily and drastically affect any user of wood waste.

Traditionally the lumber industry has shown marked fluctuation directly related to the home builing industry. As a result, generation of waste has also fluctuated. Any user whose supply of energy is contingent on wood waste is well advised to be aware of possible radical fluctuations in the parent industry, i.e., the lumber market. With this in mind any potential user would be advised to have several long range contractural supply agreements.

The major sources of supply are usually available in areas with logging nearby: 1) unused slash, and 2) sawmill residue. Slash is partially used as firewood for homeowners. Though slash (residue following logging) is available in large quanitites, its current accessability is limited, and/or it is currently being burned.

Assuming logging methods are not appreciably altered, analysis proves the removal of slash with known equipment and methods is uneconomical. The problem essentially is how

to move widely scattered slash piles closer to roads so they can be chipped and loaded into vans or small trucks. The most obvious logging equipment to use would be rubber tired skidders. The skidder is costly and designed to move uniform logs in bunches. Attempting to use the skidder for moving randomly sized scattered tops and limbs simply would not be feasable. (See Scenario #1). One logger estimated a skidder could move approximately 1,200 pounds of merchantable timber and only three to four hundred pounds of slash.

The policy of buring slash, I don't feel, is any real impediment to a potential user. Most land owners and Forest Service personnel would be happy to have somone remove the slash for other purposes. (However, some will agrue that the charred remains add to the nutricent cycle of the soil.) Generally, though slash has been considered a nuisance.

At present, however, the problems of accessability remains the key impediment to slash utilization. Contemporary logging methods involve the "skidding" of merchantable timber to "log decks" situated along the sides of logging roads nearby. The remainder of the felled trees are essentially piled in scattered areas, making them relatively unaccessable to portable chippers, total tree chippers, etc. The additional cost of skidding the cull logs into log decks presumably for firewood or other uses has, with only one major exception, been considered uneconomical. At present the economies of skidding cull logs into decks without concession has been unfavorable.

The one major exception to the unfavorable economic feasabilities of harvesting the cull logs this writer is aware of is a small company called the Slash Utilization Corporation

located in southern Oregon near Medford. Through relatively new (last year) the founder of this company claims he can remove slash in conjuction with his logging business. Forest Service personnel and other experts are very interested in his unique approach. Part of his incentive is a rebate he receives from the Forest Service for removing the slash. The Forest Services in this case considers it to their advantage if the logger can remove the slash with a resulting saving to the Forest Service. The Slash Utilization Corporation reportedly hauls the cull logs or unmerchantable timber to a central location where it chips the logs in a small chipper then sells the chips on the chip market. No data was available to substantiate the workability of this procedure at the time of this report.

If logging methods should change in the above manner or in some way not known to this writer so as to facilitate accessability it should be noted that an abundant supply of slash would be available for residential or commercial use. For the purposes of illustration, the U.S. Forest Service, in the Helena National Forest, has current timber contracts to log a total of thirteen million board feet. Four large sales account for eleven million board feet of the total amount. On an acreage basis the four large sales would cover about 1,200 acres. The Forest Service estimates the average slash remaining after merchantable timber is removed to be approximately 44 tons per acre. Consequently, 52,800 tons of slash from these four sales alone will be yeilded within three years. The Forest Service expects about half of the total contracts in force to be logged in 1981 or 26,400 tons of slash from the four large sales in 1981. (As will be shown later, liberal calculations show an institution the size of Lewis and Clark's Cooney Convalscent Home

requiring 1,134 tons of slash annually). However, it should be pointed out that a portion of the slash remaining would not be salvagable (needles, small branches, etc.). If it were assumed that only one-half of the remaining slash were useable then next year (1981) 13,200 tons of slash would be available from only four timber sales in one National Forest.

Several additional factors worth noting are: 1) current contracts are predominatly Lodgepole Pine which contains less BTU's than Douglas Fir; 2) the U.S. Forest Service has a computerized debris prediction program that may be of use to a potential user; 3) in 1981 the U.S. Forest Service (Helena National Forest only) plans a total of eight million board feet of which two thirds will be Douglas Fir; and 4) any potential user would alo have private lands and other National Forests in close proximity as a source of supply.

Nevertheless the widespread introduction of such operations may have a limited duration with the implementation of the National Forest Utilization Act of 1980. This bill which provides for removal of cull logs and the establishment of pilot wood yards for public firewood would essentially change the nature of logging on National Forest lands and could essentially exhaust a supply alternative any major commercially sized user might be considering. Clearly this legislation dramatically effects supply of slash for commercial industrial purposes.

It should also be noted that slash in close proximity to Helena is being relied upon heavily as a source of firewood. Between the spring of 1980 to fall of 1980 this writer had the opportunity to accompany Forest Service personnel as

well as private loggers conducting visual surveys of slash within a 25 mile radius of Helena. In the opinion of this writer, readily available firewood is getting scarce. The institution of a commercial wood system of chipping slash for industrial fuel could adversely affect the supply of firewood in the Helena area. This in turn would have the effect of serioulsy disrupting an existing technology, i.e. small residential woodstoves.

THE DENSIFICATION OPTION AND DIRECT COMBUSTION

Densification of raw biomass is not a new phenonenon even in the 1940's the Presto Log Company of Lewiston, Idaho was producing what was called "stoker fuel". Stoker fuel contained the mass of about six or seven of the smaller pellets manufactured by the current producers of densification processes.

Though the densification process has been used in areas besides the forest products industry this report focused on techniques for densifiying forest biomass. (Commonly referred to as DBF, for Densified Biomass Fuel).

Much of the discussion from the emerging field of utilizing biomass as an alternate energy source relates to major densification plants. It is well worth noting that these systems are costly. Current estimates for construction of these plants ranges from 2.5 to 5 million dollars. Puveyors of these systems maintain that a continuous abundant supply is crucial for a successful operation. This becomes clear when considering the capital cost. Gaurantee Performance Company of Independence, Kansas attributes much of their difficulty in Minnesota (plant closing) to an exhausted source of supply.

Essentially, there are three steps in the densification process:

1) Drying
2) size reduction
3) Pelletizing

Because raw biomass is often as much as 50% moisture, the drying process is intended to produce a moisture free fuel, with more useable BTU's. The size reduction further enables the production of densified pellets. And finally, the pelletizing process, or densifier produces a uniform pellet with essentially more mass per volume than the feedstock. <u>It is important to note that there is no overall increase in the amount of BTU's present in the final densified fuel than in the original feedstock</u>. One Oregon engineering consultant wrote in 1979: "because it is waste, one obviously limits processing to the minimum".

Manufactures selling densification plants point to the following as reasons for densifying:

1) ease of handling and transportation (less cost)
2) little or no conversion necessary in conventional coal fired boilers
3) less pollution
4) fewer equipment breakdowns because of uniformity in size
5) low sulfur contents
6 greater combustion efficiency

In western Montana almost all of the older coal fired boilers have been converted to gas or oil. As a result, according to State Boiler Inspector, Paul Rafferty, there is no way of converting these old boilers back to solid fuel. Mr. Rafferty maintains that current saftey agreements could not be met.

Storage of densified fuel tends to be more critical than green fuel. DBF will tend to degrade or fall apart if it becomes wet. Hence, silos or well sealed buildings become necessary. (Silos generally cost about $80,000).

The combustion efficiency of DBF is higher than green wood chips because of compaction and low moisture content (10%).

COMBUSTION EFFICIENCY

Coal	0.825
Fuel Oil	0.80
Natural Gas	0.778
Wood Pellets	0.778
Wood Chips (green)	0.67

(Compliments of SERI, Golden, CO)

However, there remains significant tradeoffs: 1) seven percent of the initial energy of the feedstock (green wood) consumed in the manufacturing process; 2) high capital cost for the construction of the DBF plant 2.5 - 5 million dollars; and 3) handling the fuel twice, compared to once with green fuel.

Although the higher combustion efficiency from the densified fuel suggests less pollutants, no clear data supports this contention. Furthermore, hog fuel boilers that burn wet fuel can easily be fitted with pollution abatement equipment placing them within allowable standards. (Dr. David C. Jung, OSU, personal interview, 1980)

Comparitively massive economies of scale could potentially provide a different scenario for DBF fuel plants providing ample existing coal fired units were in close proximity. (Not applicable to this study.)

The other main option available to a user is direct combustion of wood wastes in hog fuel boilers. This step involves none of the costly processing necessary in DBF plants. Essentially the additional cost involved in this approach is the hog fuel boilers themselves ($165,000). Of course, transportation costs at one point will be greater because DBF is uniform and dense. Hog fuel and chips are ramdomly sized and require about three times the volumne (shipping and storing).

However, a key omission by proponents of DBF plants is that the fuel essentially is handled twice; once from the supply source to the plant and then from the plant to the eventual user.

Although a simplification, this writer feels it is fair to compare the two approaches (DBF vs. direct combustion) in terms of the key costs involved. A DBF system essentially involves the construction of at least a 2.5 million dollar plant, whereas a direct combustion system would involve a hog fuel boiler plus installation - $275,000. Clearly, this writer finds direct combustion preferable in a systems approach.

STORAGE

Storage ranges from the simplist, least costly part of a wood waste system to a problem that can prohibit its introduction in an instituion.

The key variable is availability of unused or easily converted space. If, for example, a building is situated on the edge of town and is surrounded by open land (such as the Cooney Home's location) then storage could present only minor problems and negligible costs. However, were the building of a potential user located in a cluster of buildings in a downtown area, a wood waste system would likely not prove practicable.

Assuming ample space is available, green wood in a hoged form or chips needs little protection and can be stored in the open. A variety of low/no cost precautions would suffice to protect the fuel from high winds and moisture. Because rainfall in our area is comparatively low construction of costly sheds and buildings would be unnecessary. (It may be adviseable in some circumstances to construct wind breaks). In most cases it would probably suffice to occassionally cover piles with a four mil polyethene covering if experience indicated the fuel was accumulating excess moisture.

Finally, because spontaneous combustion and the resultant fire hazard it is suggested that piles be limited to a height of 16 feet.

	Days Inventory					
Conversion System	5		10		30	
Million BTU's/hr	cu ft	tons	cu ft	tons	cu ft	tons
5	8,800	106	17,600	212	52,800	636
10	17,600	212	35,200	424	105,600	1,272
20	35,200	424	70,400	848	211,200	2,544

(compliments of SERI, Golden, Colorado)

BOILERS

The actual combustion of wood residues in an institution involves an array of possibilities largely determined by: 1) needs; 2) layout of existing facility, and 3) type of boiler currently in use. The first and seemingly simplest alternative would be retrofitting of existing boilers. This is in almost all cases, in Montana, a difficult alternative for at least two major reasons: 1) extent of necessary modifications, and 2) space.

Boilers originally designed to burn gas or oil are significantly different in their combustion capability, so that conversion to wood requires almost a total rebuilding. Most experts agree this alternative is not feasable. In addition the boiler rooms built exclusively for gas or oil boilers simply do not have the space available to handle the volumes of wood fuel or the space for ash removed.

This writer initially viewed old coal fired boilers as simple retrofits for wood fuel. Because of boiler room size, feed system and firing capabilities in many cases old coal boilers can accept solid densified biomass. However, Paul Rafferty, the State Boiler Inspector calls attention to what he considers an irreversible modification. In Montana, almost all old coal fired boilers have been modified for gas or oil. When this change took place the melt-out plugs in the fire boxes were permanently modified. This according to Mr. Rafferty was a key factor in boiler safety for solid fuels. (The plugs essentially melted out when boilers reached dangerous temperatures.)

One other key option available for a potential user would be the installation of a multi-fuel boiler system. These boilers are designed to burn a combination of fuels, either separately or together. The advantages of these boilers could be crucial in that they allow for flexibility in fuels used. Hence, if for example, natural gas prices soared beyond wood, then wood could be used. (Most multi-fuel systems will accept coal, wood, oil and gas). Another key advantage of a multi-fuel system for any user planning to relying on wood waste, would be an ability to adapt to another fuel should the supply of wood be exhausted.

The prime disadvantages of a multi-fuel boiler is inherent in the combustion properties of different fuels. According to Gene Hawks, Regional Energy Coordinator, USDA in Missoula, the ratio of volatile gases in the different fuels makes construction of an efficient multi-fuel system very difficult. Finally, the initial cost of multi-fuel boilers is about three to four times of conventional fossil fueled boilers.

<u>Hog Fuel Boilers</u>

Hog fuel boilers accept all kinds of wood waste residue when reduced in size by a reducing machine called a hog. High moisture content is no barrier, the boiler system is designed for it. However, because the hog boiler accepts fuel that has a great deal of volume and requires much handling, it is larger and more complex than conventional fossil fueled boilers. Consequently its initial cost is much greater.

Cost Data

3 to 14 m BTU/hr	Boiler
15 PSI	150 PSI
$165,000	$250,000

(Courtesy Wellons Manufacturing)

Nevertheless the hog fuel boilers cost when viewed in a system approach is relatively low.

If any kind of convential boiler is used other equipment must be used to make wood fuel useable. At the very least the moisture content would have to be reduced which would require an industrial dryer. These machines typically cost $80,000 as well an the additional step in handling would required another added cost. In many cases standard boilers would experience frequent problems without size uniformity of the wood fuel, - hence the introduction of a uniform densified biomass, a very costly proposition.

Finally a hog fuel boiler stands a much greater chance of lasting longer than wood boilers using a densified biomass which burns hotter. The high moisture content in hog fuel simply keeps the components cooler.

Much of this section draws heavily from the work of David C. Junge, author, Boilers Fired with Wood and Bark. Currently Director Energy Research and Development Institute, Oregon State University, Corvalis, Oregon.

ECONOMIC POSSIBILITIES

(SCENARIOS)

General Comments

It should be noted that the investigative focus of this paper was slash utilization protential in the Helena, Lewis & Clark County area. A 1976 compilation by the University of Montana's Bureau of Business and Economic Research clearly shows Lewis and Clark County has a very slight percentage of the total logging activity in Montana. In 1976 logging in Lewis and Clark County amounted to only 2% of the state total or 28 million board feet, while Lincoln was 293 mmbf (25%), Flathead 233 mmbf (20%), Sanders 153 mmbf (13%), Missoula 152 mmbf (13%). Clearly economies of scale not applicable in Lewis and Clark county may apply in other Montana areas with over ten times the logging activity.

Another key factor that could relate to wood waste utilization for energy in Montana is competing demands from the forest products industry specifically the pulp and paper mills and the particle board industry. However, at this time incidence of the forest products industry using slash in Montana is unknown to this writer.

One final crucial factor affecting supply of wood waste is interest rates, and the resultant effect on housing starts. Although difficult to predict, at the time of the writing it appears logging will not experience a dramatic resurgance in the near term.

Although not specificially addressed by this study it should also be pointed out that Champion International, Missoula, is nearly complete with installation of the largest hog fuel boiler in the United States (David C. Junge, Professor, OSU, Corvalis). The company reportedly plans on using 90% of wood residue generated at sawmills around the state. If slash could be removed economically (via government concessions) it is not inconceivable that Champion International could be a purchaser for its massive hog fuel boiler.

Assumptions

The intent of compiling the following Scenario's was to draw as complete a picture of the types of equipment and personnel involved in establishing a commercial wood waste system as is feasable. Of course what follows are only several possible options in a complex system with an array of possibilities. The authors have attempted to compile the most realistic scenarios given the existing variables mentioned throughout this report.

Three basic key assumptions are made: 1) no initial cost for the slash; 2) landowners are willing to engage in contractual agreements insuring a no/low cost supply for an extended period of time; and 3) the wood fuel will be combusted directly (with no densification plants in the scenario) in hog fuel boilers.

The following Scenarios are based on:

ENERGY SUPPLY NEED ANALYSIS FOR 2.1 MILLION BTU's PER HOUR BOILER (ANNUAL)

and...

THESE ASSUMPTIONS:

I The following calculations are based on boiler operating at full capacity for 180 days.

II The fuel supply is assumed to be chipped wet (50% moisture content) Lodgepole Pine which will yield 4,000 BTU's per pound or 8 million BTU's per ton. (Conservative because of possible additional moisture absorbtion during storage)

From the above it can be assumed that on a 24 hour day, 50.4 million BTU's per day are required (24 x 2.1). Annually then 9,072 million BTU's would be needed (180 x 50.4). Requiring 1,134 tons of chipped Lodgepole Pine.

(1980 - 1981 projections, Cooney Convelscent Home projects to spend $22,885 on natural gas at $3.44 per mcf (current price).

SCENARIO #1

Scenario #1 assumes that an organizational entity governmental or private owns none of the equipment necessary for removal of slash from the woods.

(Not included in this analysis and of import are the tax incentives, accelerated depreciation schedules and government guaranteed loans and grants available for alternative energy utilization plant such as this.)

Scenario #1 is an assemblage of equipment the author deemed necessary for the gathering of wood fuel. Essentially the operation would involve: 1) a skidder to move the slash closer to the logging road; 2) a crawler type tractor to move the slash closer to the chipper as the operation continued; 3) chain saws to buck and limb slash before it enters the chipper; 4) cippers to chip the slash into a useable fuel and 5) an assorted parts inventory and tools to keep the operation running.

SCENARIO #1

Capital Equipment

Portable chippers (2) (used) @ $7,000 ea.	$14,000
Rubber tired skidder (used)	$30,000
4x4 Pickup trucks (2) (used) @ $5,000 ea.	$10,000
Chain saws (6) (new) @ $400 ea.	$ 2,400
D-6 Crawler type tractor w/ 12 ft blade	$30,000
Assorted tools	$ 2,000
Parts Inventory	$ 1,200
2 Gas powered 2 ton trucks (diamond bed w/ mesh) (used) @ $15,000 ea.	$30,000
TOTAL	$119,600

Operations Costs
(Annual)

Personnel	Wage per hour
Mechanic (1)	$15.00
Skidder Operator (1)	$15.00
Sawyers (3)	$12.00
Truck Drivers (2)	$10.00
Laborers (2)	$ 9.50
Foreman (1)	$15.00
	$192,000.00

(Assumption is made that an existing entity, private or public with an existing administrative structure for salaries and supportive services.)

SCENARIO #1

S U M M A R Y

Total Cost Capital Equipment	$119,600.00
Total Cost (Annual) Personnel assuming 200 days operation for a total of 2400 tons	$192,000.00
Amortizing the used equipment on a three year basis	$ 39,866.66 per year
Excess chips saleable in chip market assuming $40.00 per ton	$ 50,640.00

(Fuel for powering machinery, not included)

SCENARIO #1

A N A L Y S I S

With a total capital equipment cost of $119,000 and an assumed payroll of $192,000 for a period of 200 days, it appears this approach is hardly feasable given the current cost of natural gas and even with significant price increases. (Remember the cost of natural gas is currently $3.44 per mcf which yields 900,000 BTU's per mcf).

The assumption in this Scenario is that the men and equipment could harvest 2,400 tons of waste wood in the 200 days.

Two trucks capable of hauling three tons, two trips per working day (total of 12 tons per day, or 2,400 tons in 200 days). The assumption is also made in this case that the chippers are capable of producing a dimensional chip, sale-able on the chip market. If chips were selling for $40 per ton it is possible the operation could generate $50,640 in revenue. Also, it is quite possible that the stipulated salaries could be dramatically cut or otherwise altered by such means as CETA Funds, or seasonal part-time help. Without drastically reducing the salaries this Scenario has little or no merit from an economic standpoint.

Consequently for purposes of analysis the author has taken the liberty to cut salaries in the model in half. The result then $96,000 may at some point make this approach more reasonable.

Annual Costs	
Personnel	$ 96,000
Amortized Equipment	$ 39,866.66
	$135,666.66
minus revenue generated from chips sale	- 50,640
Total Cost to Retreive Chips	$ 85,026

To continue the systems analysis remember that a hog fuel boiler would need to be installed at a total cost of $275,000. With a ten year expected life. Amortization would yield a $27,500 annual cost for this component.

COMBUSTION In plant needs 2 - 14 million BTU's/hr.

Capital Investment

Hog fuel boiler with feed system pollution control devices and all related accessories		$165,000
Installation, (with pad)		$110,000
	TOTAL	$275,000

System Cost
(Annual)

Boiler		$ 27,500
Total Annual Cost To Retreive Chips		$ 85,026
	TOTAL	$112,526

With a $112,526 annual fuel cost for wood fuel compared to $22,885 projected 1980-81 natural gas price, clearly the scenario presented here is not advisable even with an array of incentives.

SCENARIO #2

Scenario #2 assumes that a governmental agency such as Lewis and Clark County would attempt to institute a total slash pile utilization plan from gathering and chipping to final combustion. The assumption here will be made that much of the equipment in Scenario #1 would already be owned by the county. Primarily the tools, trucks for transportaing the fuel from the woods and chippers.

The chippers could be purchased with a dual purpose 1) roadside maintaince and 2) fuel harvesting. Hence, for this model chipper cost will not be included as a capital investment.

Capital Investment		
Skidder		$30,000
D-6 Tractor		$30,000
Assorted parts		$ 1,200
Chain Saws		$ 2,400
	TOTAL	$63,600

Once again with an assumed amortixation of three years on the used equipment the following can be stated.

Annual Costs	
Personnel	$96,000
Amortized Equipment	$21,200
Minus Revenue from chip sales	$50,640
Total Cost To Retreive Chips	$66,560

Now, in this Scenario with the total cost of retrieving the chips at $66,560 and the amortized cost of installing a hog fuel boiler ($27,500) the situation is a little more promising. Now, with a total annual cost of $94,060 the system could at some future date prove feasable.

Of course with this model gas would have to be considerably higher than todays price to make the system viable.

However, at least four factors could substantially decrease the system cost of annual operation:

1. Elimination of some of the capital equipment such as the skidder, which may not prove necessary to efficient systems operations.

2. Further reduction in salaries and personnel.

3. A reduced price from the manufacturer of the hog fuel boiler.

4. Economic incentives in the form of tax incentives and grants.

Finally, equipment innovations for slash removal could drastically change the scenario. At this point though, in view of the environmental factors, and the existing firewood supply, this writer would not encourage such an enterprise.

FINAL CONSIDERATIONS

The 80's will present difficult decisions in the area of energy use, planning and the resultant cost. One thing is clear, no simple solution is on the horizon. Strong leadership will be required to make the difficult decisions involving the capital expense necessary for conservation and alternative solutions.

Wood, as a renewable energy source is limited by virtue of our climate. At present it is being highly relied on as a source of firewood in homes. Though this has and will continue to present a problem with respect to air quality.

Implementation of commercial/industrial wood waste systems that relied on slash piles could disrupt a supply of firewood already growing scarce. Because the residential wood stove is already in place as an alternative technology, disruption of its supply source by major commercial and industrial users hardly seems justified (regardless of current economics.)

It is the opinion of this writer that conservation by the upgrading of the thermal effeciency throughout the building structures, however, should proceed at once. Most commercial size structures are nowhere near sensible levels of conservation. The membranes of almost all older structures are typically under R7, far below ASHRAE standards.

The National Center for Appropriate Technology in Butte now recommends R40's in sidewalls and R60's in ceiling for homes. Based on the above, it becomes clear that our most

obvious first step would be to upgrade our conservation effort. No doubt we need tax incentives and other aids to proceed with due celerity.

To save energy and cut operating budgets, solar, wood waste conservation systems geo-thermal all can make contributions to use in near future and it behooves us to implement these alternatives as a new term plausibility - not as panaceas in themselves but as very necessary additions to our total energy needs.

RAE PROGRAM EVALUATION

I am pleased and honored to have been a part of our State's Renewable Energy Program. Though the idea presented does not prove workable it was worth exploring as part of the solution to our increasing need for alternative energy options. The funds were well spent in our effort to explore all aspects of instituting a wood system.

I felt a genuine interest from the staff of the renewable Energy Program and was pleased to have their support. At several points they supplied me with key data sources and were prompt in processing payment requests.

However, one change I feel would be helpful to grantees would be a change in the payment procedure. The fund disbursement was too slow for this grantee. Often a two week lag between the time funds were requested and received became a source of frustration. A two week lag might be tolerable were it not for the stipulation of only one payment request per month. I would suggest a more workable fund disbursement plan.

I personally do not plan any more involvement (other than projects already committed) in pioneering energy alternatives and consequently do not foresee any future funding requests from the Renewable Energy Program. Nevertheless, I strongly feel the need for the strengthening and continuance of the Renewable Energy Program as Montanan's excersize leadership in what has become this nations most urgent need, the need for energy and energy alternatives.

Sincerely,

Herbert C. Winsor
Project Coordinator

PROJECT BUDGET

FINAL EXPENDITURES

(Actual)

Personnel	Salaries
Herbert C. Winsor Project Coordinator	$3,956.00
Marita Martiniak Administrative Secretary Responsible for administrative assistance, typing and bookkeeping.	$ 326.00
Tom Winsor Advisor	$ 31.25
Sue Reicher Project Evaluator	$ 200.00
TOTAL SALARIES	$4,513.25

Operating Expense	
Supplies	$ 65.75
Telephone	$ 68.44
Travel	$184.30
TOTAL EXPENDITURES	$318.49

GRAND TOTAL	$4,831.74

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15 copies of this public document were published at an estimated cost of $3.50 per copy, for a total cost of $52.50, which includes $52.50 for printing and $.00 for distribution.